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Planning Approaches to the Management of Water Problems in Mexico

Laura C. Ruelas-Monjardin
El Colegio de Veracruz
 Mexico

1. Introduction

Water scarcity is a worldwide issue. March 22nd has been declared by UN-Water & FAO, as the world water day. The 2007 world water day theme was “Coping with water scarcity”. Water scarcity is defined as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully” (UN-Water & FAO, 2007, p.). Although scarcity could be a social construct or the consequence of changing patterns in water supply, there are many options of being remedied or alleviated. Traditionally, it has been addressed through supply or engineering oriented solutions more than enforcing conservation options. Supply oriented approach assumes that water scarcity problems only exist when there was not enough water to meet social and productive demands. Increasing water supply infrastructure solves the water shortage problems. Under this approach, the main problem is how to identify a need and then how to make water available. As a consequence, dams, reservoirs and facilities for meeting these increasing human needs have been built, and rivers and streams diverted. Currently, 45 000 big dams, plus another 800 000 smaller ones have been built (MEA, 2005). Although this infrastructure building has brought about positive effects, negative effects have also been perceived. For humans, positive effects have been in terms of stabilizing flows for use in irrigated agriculture, flood control, drinking water supply and hydroelectricity production. Negative effects are given in relation to capital costs per cubic meter of new supply are doubling every decade, environmental effects are more severe, and adverse effects on indigenous peoples are no longer acceptable (MEA, 2005). As a consequence of these effects, the water supply model was restructured in the Johannesburg World Summit on Sustainable Development in 2002. In fact, the failure of this model was recognized by the World Bank long time ago, during the Ninth Irrigation and Drainage Conference in 1992. Since this conference, it was recommended the need to change this approach. Two key constraints of this approach were pointed out, namely the increasing scarcity of water and the higher costs of projects both in technical and environmental terms. Furthermore, it was also recognized that a focus on the technical supply issues and less on how water was used and disposed of, left open the expectations that additional quantities of water supply could always relieve scarcity (Easter, et al. 1992). Although in Mexico, this approach has been reviewed as a consequence of the increasing costs necessary to exploit new water sources, in practice it still

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continues to be the favorite. The National Hydrologic Plan 2007-2012 (CONAGUA, 2007) promotes the demand and integrated approaches, provided that water quantity and quality issues are critically emerging. However, the results so far achieved indicate that the supply oriented approach is still supported, despite problems like scarcity, competence and mismanagement are becoming sources of conflicts. This chapter's aim is to provide an overview of how the planning approaches to water management have been implemented in Mexico and to what extent they have resolved critical issues like scarcity. This overview is basically supported on document review that has been published about water management approaches, as well as in official reports that the Mexican government has released. Although this chapter addresses the issue of scarcity in terms of planning, it would be worth exploring it since the social scarcity capacities. Because this perspective sustains that most than the physical problem, it is the intellectual base which constraint the development water based. The development of this social scarcity capacity will also help to face critical problems related to the ecosystem demands in terms of environmental flow and not least important, the variability climate change will pose on water availability.

2. Planning approaches for water management

In Mexico and worldwide, three main planning approaches have been implemented to manage water problems. Such planning approaches are: Supply oriented approach, demand oriented approach and integrated/holistic approach.

2.1 Supply oriented approach

For more than three centuries, and until the 1950s and 1960s, water management was designed to satisfy the basic functions of health and food production (Grigg, 1996; White, 1998). Policymakers were traditionally driven to manage water to make it available to people for these purposes (Al Radif, 1999). Under this approach, the main problem was how to identify a need and then how to make water available. These needs were purely conceived as a result of population growth and agricultural and economic development, and not as policy issues (Hoekstra, 2000). A common assumption of this approach was that water shortage problems only exist when there was not enough water to meet social and productive demands. Furthermore, water availability only should be assessed in qualitative and quantitative terms. Increasing water supply infrastructure solves the water shortage problem. At the international scale, the supply approach was behind the massive expenditure of the Water Supply and Sanitation Decade project. This project was designed to provide safe water and sanitation services worldwide to 1 300 million people without access to these services. However, the worldwide problem of water shortage was not solved. Despite the activities initiated during this decade, by the end of the 20th century, approximately 1.2 billion people still remained without access to safe drinking water, and 2.4 billion lacked adequate sanitation services (Dieterich, 2003). Also, it has led to over-use of the resources, overcapitalization, pollution and other problems of varying severity (Sharma & Vairavamoorthy, 2009).

For these reasons, the water supply model has been severely criticized. Certainly, the first Water Supply and Sanitation Decade was a landmark for the supply-oriented approach. However, the evaluation on how the inadequacy of institutional arrangements for water management proved the basis for new arrangements more similar with a demand oriented approach. These changes can be appreciated in table 1.

Institutional arrangements in the supply oriented approach	Institutional arrangements in the demand oriented approach
Water development	Water allocation
Emphasis on water quantity	Emphasis on water quantity or quality-quantity
Water and sanitation as basic human needs	Water and sanitation as basic human rights
Water as a social good	Water as an economic good
Centralized management and administration	Decentralized management and administration
Government provision	Government facilitation
Administrative domain	Service provision
Water supply	Water services
Production orientation	Customer orientation

Table 1. From supply oriented arrangements toward demand-oriented arrangements for the UN Water Decade 1980s, 2000 (adapted from Sepala, 2002)

2.2 Demand oriented approach

Water demand management has been defined as an approach that encourages the efficient use of existing water supplies, rather than developing new ones. It proposes that this can be achieved through policy, which involves ethical, economic, educational and technological consideration (Van der Merwe, 1999, cited in Schchtschneider, 2000). The logic of this approach is that as water availability is limited, demand cannot continue to increase, and water needs should be satisfied with the available resources (Hoekstra, 2000). Under this approach ‘needs’ and ‘wants’ means different things. Water use is a ‘need’ if it is related to the fulfillment of basic needs, and in principle, these needs cannot be manipulated because they exist independently of economic or political status. But the ‘wants’ for water imply additional water based goods and services, and then they are considered a luxury and largely subject to social and political desires. At the community level, water ‘wants’ are though to be largely a function of customs and human behavior, which may change through an improvement of environmental awareness or through the imposition of water taxes (Serageldin, 1995). The demand-oriented approach was the slogan that characterized the international water policy and strategies of the 1990s, which were discussed in the most important international forums. In the Third World Water Forum held in Kyoto in 2003, it was recognized the potentials of this approach and promoted it, in order to improve the economic performance of the water industry. In this forum, water was valued as an economic good and as consequence there was a need to move towards pricing it in order to recover the cost of service delivered (The United Nations, 2003). In summary, the demand-oriented approach seeks to achieve the satisfaction of the water needs by improving the efficiency of water use rather than by increasing its supply. This approach places water demands themselves, not structural or engineering solutions, at the centre of concern. It recommends the development of large, capital-intensive structures only after other possible options for lowering or mitigating the proposed water demands have been fully analyzed. It represents the cheapest form of easily available water, particularly in areas where additional demands are being placed on water resources that are already stretched to their limit (Baumann et al., 1998; Butler & Memon 2006, cited in Sharma & Vairavamoorthy, 2009). In

the pursuit of efficient water use, market mechanisms and private sector participation would be allowed. Many countries, to different degrees have allowed and actually encouraged the participation of the private sector. For example, “full” privatization is to be found in England, Wales and the Czech Republic; investor-owner privatization in the US, and private concessions in France, Spain, Portugal, Poland and Mexico (Rogers et al. 2002). Despite its international acceptance, this approach faces big challenges. These areas related to the change in the perception of society about the true value of water and the need to instill an attitude of responsibility towards the resource as a whole. On the other hand, water management as a commodity has been identified as a complex issue. Water should fulfill at least, six prerequisites in order to be treated as another commercial commodity:

- It must be capable of being controlled, measured and treated as a commercial commodity
- The demand must exceed the supply
- The product must be provided when needed
- It must have sufficient mobility to be transferred to where it is most needed
- There must be acceptance of the market by society
- There must exist some mechanism of administration and regulation to assure fairness and equity (Campos & Studart, 2000).

Adherence to these prerequisites has been a difficult task, because as well as tackling the hydrology issues, there also needs to be an understanding of the rights for its use both in terms of law and popular habits.

Drawing on the previous arguments, it is evident that supply and demand planning approaches for managing water problems still face enormous challenges. There is an increasing consensus on the need to carry out an integrated and holistic management of water resources in order to prevent conflicts as well as to meet social and natural demands (Martinez-Austria, 2001; Jaspers, 2003).

2.3 The integrated/holistic approach

Integrated water resources management is an internationally recognized approach to develop sustainability in water resources. It has been regarded as necessary to combat increasing water scarcity and pollution. Integrated approaches have taken many forms, including integrated river basin management, integrated land and water management, ecosystem approach, integrated coastal zone management and integrated natural resource management. They seek integration of all the beneficial uses and costs associated with land use and water decisions, including effects on ecosystem services, food production and social equity, in a transparent manner; to involve key stakeholders and cross-institutional level, and to cross relevant bio-physical scales, addressing interconnectedness across subbasins, river basin, and landscape scales (Falkenmark, et al., 2007). Consequently, a high level of coordinated interaction between all these key stakeholders is needed in order to they can collectively analyze the consequences of their actions. Despite everybody is clear about the need of coordination it is often incredibly difficult to achieve it. One of the key barriers for coordination is how to deal with uncertainty. According to Kreitner & Kinicki (1992), some of the factors that contribute to uncertainty are:

- unclear objectives;
- vague performance measures;
- ill defined decision processes;

- strong individual or group competition or
- any type of change.

All these are strongly present in most integrated water resources management situations.

On the other hand, Vissher et al., (1999) based on DANIDA (1991), (NEDA, 1998) and (UNDP, 1991) pose that integrated means development and management of water resources as regards both their use and protection, and considering all sectors and institutions which use and affect water resources. As well as the need to include a consideration of the whole water cycle, including rainfall, and both “blue” – ground or surface water – and “green” – soil moisture – components of the resource in order to gain a truly holistic overview. Methods for achieving this integration include water conservation and reuse, water harvesting, and waste management. Although an appropriate mix of legislation, pricing policies and enforcement measures is essential to optimize water conservation and protection. For guiding the implementation of the integrated approach, eight principles have been recommended, such as:

1. Water source and catchment conservation and protection are essential
2. Water allocation should be agreed between stakeholders within a national framework
3. Management needs to be taken care of at the lowest appropriate level
4. Capacity building is the key to sustainability
5. Involvement of all stakeholders is required
6. Efficient water use is essential and often an important “source” in itself
7. Water should be treated as having an economic and social value
8. Striking a gender balance is essential.

Despite the international consensus on these principles, the challenge remains in translating them into action. In this sense, the Mexican country will be employed as a testing ground to analyze the extent to which the supply, demand or integrated approach had been adopted in the decisions on water resources management.

3. The Mexican experience on water resources planning and management

3.1 Supply oriented approach

México is proud of its long standing tradition in hydraulic infrastructure development. This tradition dates from the creation of the so-called “commissions” oriented to river basin development. These commissions were inspired in the Tennessee Valley Authority developed in the United States to promote regional development. In Mexico, they were conceived as a way of planning and coordinating public expenditure in regions where it was difficult to do because of already established ministries and state governments (Barkin & King, 1970). Politically, they provided an opportunity for the central government to intervene in deprived regions. It was a way of gaining votes for the next government, through the construction of big facilities (Dourejeanni, 1998). In the thirteen year period that lasted these commissions, 8 of the 52 most biggest dams were built. As displayed in table 2, during 1947-1960, 7 Basin Hydrological Commissions were created.

Although, one of the attractive characteristics of these Commissions was their ability to work simultaneously in several states in projects that involved different ministries, the success of these projects was constrained by political and managerial factors. Although after the 1960 decade, these commissions disappeared and the building of big dams descended, after the 1980 decade 16 more dams were built. Perhaps, this emergence is joined with the international compromises Mexico engaged for the 1980 decade of Water and Sanitation.

River basin	The basin scope
Papaloapan River Commission	It was created in 1947. It covered an area of 18 000 square miles. It included parts of the states of Veracruz, Puebla and Oaxaca. Sugar cane was the most important crop. One of the largest dams in Latin America was built here, called “Miguel Aleman”
Grijalva-Usumacinta Rivers Commission	It was created in 1951. It covered an area of 48 000 square miles. It comprises states of Tabasco and Chiapas. Their combined run-off averages nearly thirty percent of the Mexican total. The largest dam in Latin America at the time it was built (1965) here, called “Malpaso”.
Tepalcatepec River Commission	It was created in 1947. It covered an area of 7 000 square miles. It included the state of Michoacan and Jalisco. It was the first of the river basin projects for developing the hot dry area of the Pacific Coast.
Balsas River Commission	It was created in 1960. It covered an area of 43 000 square miles. In this year, this Commission also absorbed the Tepalcatepec Commission. The Balsas is the larges Mexican river. Also, two large dams were built here, called “El Infiernillo” and “La Villita”.
Fuerte River Commission	It was created in 1951. It covered an area of 12 000 square miles. The El Fuerte river is the largest river in the northwestern region of Mexico, in terms of flow. It drains in areas of the state of Sinaloa, Sonora, Durango and Chihuahua. This Commission contributed to the north western agricultural development of Mexico. A dam, called Miguel Hidalgo was built for this purpose, as well as controlling floods.
Lerma Santiago and Chapala Projects	It was created in 1950. It covered an area of 50 000 square miles. This project included the largest river basin wholly included within the Mexican borders. This Project was different from the previous Commissions, because its function was to study the problems of the basin and the making of recommendations to other agencies of the Mexican government.

Table 2. The Basin Commissions created in Mexico during 1947-1960 (Barkin & King, 1970)

However, the delivery of tap water and sanitation as a result of constructing these big reservoirs did not reach local population. For example, the biggest reservoir is located in one of the three most deprived Mexican states. At least two reservoirs located in the State of Chiapas represent 10% of the total storage capacity in dams. In this state, just 73.5% of population has access to tap water. This figure is below the national mean, which is 89.2%.

Due to the strong social resistance to dams, in the 2000s decade, only one dam was built. Avila et al. (2005) pose that water scarcity has been accentuated by the perverse subsidies to electricity for water pumping, with almost US\$700 million per year, and the failure to price water according to its scarcity.

However, most part of the National Water Commission budget continues to be allocated for infrastructure development. In 2008, 65% of the total expenditure was employed for delivering drinking water, sewerage and sanitation; 20% for promoting water efficiency in agriculture and; 15% for administration and water preservation (CONAGUA, 2008).

Therefore, it could be said that supply approach continues dominating Mexican water policy. Even more, if it is considered the increase in climatic variability, the concern about the decline of petroleum resources and the accelerated search for alternative renewable energy. Electricity demands are forecasted to increase dramatically with the need for more industrialization.

3.2 Demand oriented approach

Since the 1981 National Hydraulic Plan established that the public management of water in Mexico faced challenges akin to this approach. It recommended that water management agencies should generate enough income to pay for the cost associated with the operation, conservation and maintenance of the systems, as well as generating necessary surpluses to meet future investment requirements. In order to face these challenges, the Mexican government designed strategies oriented to decentralize and modernize the water management sector. These strategies entailed a structural break with the previous model of stat-led-development, which has been operating since the 1940s (Castro, 1995). This process broke with traditional policies in the sector, whose main feature was the role of state as supplier, donor and benefactor. In water services, the modernization and decentralization processes has meant a transfer of responsibilities of water management, from the state towards the participation of the private sector through diverse and complex mechanisms. These measures provided the formal basis for the creation of water markets by conferring water the status of a private property resource. According to the Global Privatization Fund formed in 1994 specifically aimed at attracting investors desiring to take advantage of investment opportunities, historically inaccessible to U.S. investors, Mexico was one of the top ten countries involved in privatization since 1985. Although Mexico undertook a privatization model based on concessions, these schemes have succeeded in the northern part of the country, in water users organizations linked to the United States market. By contrast, southern water user' organizations have not prospered. This contrast support the idea that most than physical scarcity, the problem lies in the social scarcity capacities to manage the water problem. According to the map displayed in figure 1, it can be seen that despite water resources are abundant in the south, and scarce in the north, economic develop does not follow this trajectory.

This figure reveals that while the north-centre-northwest regions hold more than two thirds of population and receive one third of precipitations, they generate 87% of the gross domestic product. Contrary to this, the southeast region sheds 23% of population, 69% of precipitation occurs there, but it only contributes to 13% of the gross domestic product. According to CONAGUA (2008) forecasts, this disparity will get worse by 2030. As 70% of population increment will occur in these water scarce regions, per capita water availability will be less than 1 000 m³/person/year. A mayor effort will be needed to address these

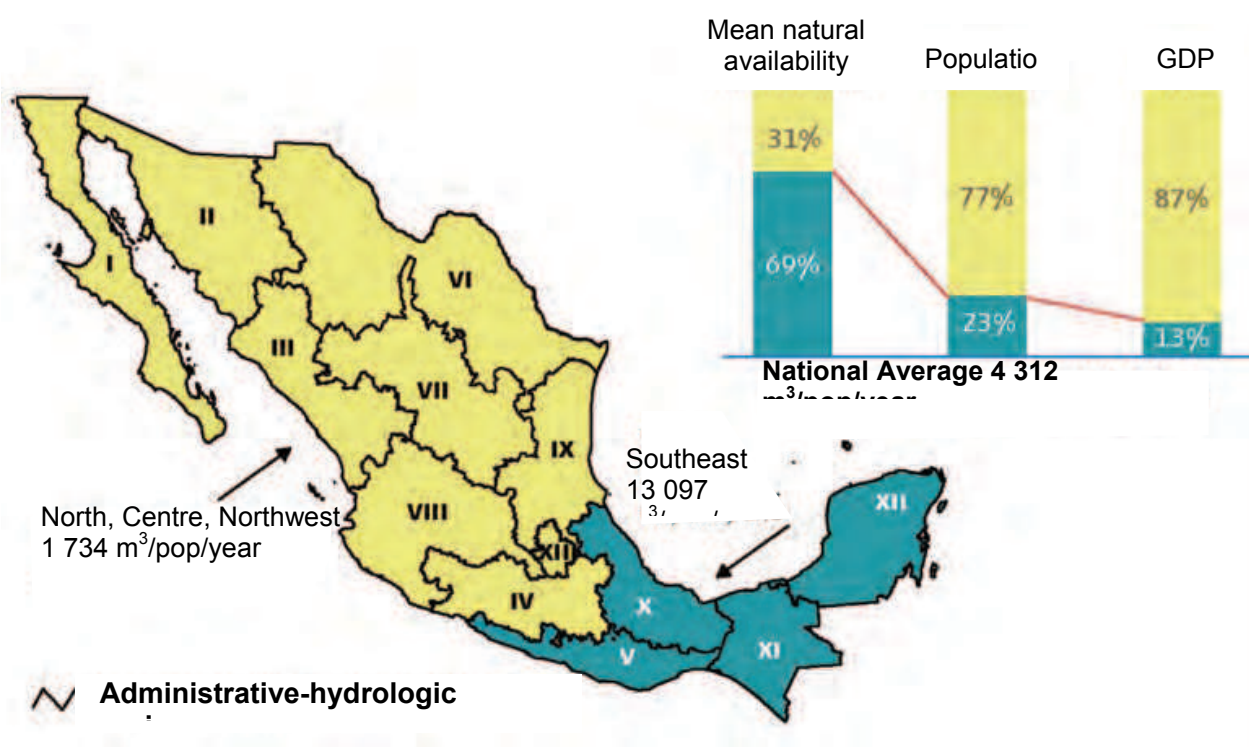


Fig. 1. Regional contrasts between development and water availability (CONAGUA, 2008)

water issues and this can only be accomplished by an integrated approach that considers the whole system, which includes the relationships and dynamic interactions between human and natural systems, land and water systems, and key stakeholders agencies and local groups.

3.3 Integrated/holistic approach

In normative terms, the Mexican water law enjoys international recognition for including reforms that consider the ecosystems needs. The law vests federal government to declare as disaster zone those basins or hydrological regions that represent or potentially represent irreversible risks to a ecosystem (Falkenmark et al. 2007). The most recent version of the national water law, establishes that water should be managed in an integrated way, which fully recognizes the relationship between water resources, air, soil, flora and fauna, another natural resources, biodiversity and the ecosystems that are essential for keeping water integrity. Also, the National Hydrologic Plan 2007-2012 (CONAGUA, 2008), establishes objectives oriented to promote the efficient use, water users and organized groups participation, and the sustainable and integrated management on watershed based.

Considering the eight principles that should guide integrated water management, it can be said that Mexico has some progress on water source protection and stakeholders' involvement.

In terms of stakeholders' involvement progresses have been made through the basin council organization.

Basin councils were designed with the important purpose of acting as mediators between the National Water Commission (CONAGUA), different governmental offices and the representatives of water users within a water basin. The potential of basin councils for solving inter-state water conflicts were recognized after the successful experience of the

Lerma Basin Council. Here serious problems related to scarcity, water allocation, pollution, water use inefficiency, environmental deterioration, surface and groundwater water rights had been detected by 1989 (Mestre, 1997; Saleh & Dinar, 2000). It became clear that the federal government action would be insufficient to solve or mitigate this chaos. Therefore, many water users, including individuals and the private sector, became involved. Following a participatory process on 13 April 1989, the federal government and various river-basin state governments signed an agreement that is designed to offer solutions to the main problems of scarcity, water allocation, pollution, water use inefficiency, environmental degradation and water rights (Mestre, 1997). Following this experience, by December 2006, some 25 basin councils, 17 basin commissions (at the sub-watershed level), 22 basin committees (at the microwatershed level) and 76 underground technical committees (aquifer level) had been created (CONAGUA, 2007). This mechanism for stakeholders' involvement has received wide political support, in Mexico and in the world. It has been effective for managing water at an integrated way and to involve groups and organization scarcely been considered under other arrangements.

In relation to source water protection, Mexico has taken steps through the environmental service payments. In 2003, the Mexican government, through the National Forest Commission initiated actions for paying for hydrological environmental services (PSAH) in water scarce areas. The rationale behind this idea was that scarcity and deforestation were closely related. Accordingly, the targets for PSAH have been overexploited aquifers. Between 10% and 25% of PSAH resources have gone to these areas, and less than 7% to the most overexploited aquifers (Munoz-Piña et al. (2008). At present, hydrological service payment programs have been recognized for compensating landowners who engage in preserving the services forest provided in watershed protecting and aquifer recharge. Compensation funds are collected on annual basis between water users. According to Muñoz-Piña et al. (2008), between 2003 and 2006, 110 million of US dollars were distributed among landowners belonging to local communities and private groups – which in total amount 500 000 ha in these protection schemes. Forest and hydrologic services deserve a great potential in Mexico. Mostly due to the high rated value and because services like wood has lost competitiveness in the domestic and international market. In fact, FAO (2009) forecast that in the event of the low economic feasibility of the forest industry, environmental services will continue gaining importance, in great part because of the public support.

4. Conclusion

In this chapter it has been established that Mexico figures among the nations facing severe scarcity. Scarcity was defined as a situation where population has less than 1000 cubic meter per capita per year to satisfy their basic needs. In order to face problems like scarcity, the Mexican government has employed three different approaches. The supply oriented approach was just conceived to solve particular problems and specific or sectoral water demands, eg. To enable and improve irrigation, to supply domestic and irrigation needs, to control flooding, to mitigate drought and to building power stations. It also involved the operation and maintenance of build facilities, like dams, but without taking heed of neither multiple water users nor carrying out any sort of management. This supply approach best moment occurred with the creation of institutions called “commissions” oriented to river basin development. The development of this model in Mexico occurred during the period of

1947-1960. In this period, 7 Basin Hydrological Commissions were created. According to David and Barkin (1970), these Commissions were conceived as a way of planning and coordinating public expenditure in regions where it was difficult to do because of already established ministries and state governments. Politically, they provided an opportunity for the central government to intervene in deprived regions. It was a way of gaining votes for the next government, through the construction of big facilities. Later, in the Mexican government programs, there was a tendency to implement demand management approaches. Internationally, it was recognised that water was a finite resource that supply could not increase because of the cost for developing new sources were high. Efficient measures were needed. So, private sector participation could take place in water provision. Private participation was allowed through concession, which means a partial participation, because government continue regaining control over the infrastructure. Integrated approaches are best exemplified in normative terms, through the national water law and the recent water hydrological programs. Specific examples of these programs are basin council organizations and environmental service payments. By December 2006, some 25 basin councils, 17 basin commissions (at the sub-watershed level), 22 basin committees (at the microwatershed level) and 76 underground technical committees (aquifer level) had been created (CONAGUA 2007). While this number appears high, it is still not enough, given that the number of basins and aquifers registered are much higher. CONAGUA (2007) has reported that there are 94 basins and 653 aquifers in Mexico. Although there is no information many more small scales needed for the effective management of water. Environmental service payment are becoming a strong initiative for protecting water sources through compensating landowners for keeping forests in headwater regions. More than 500 000 ha has been included in this scheme. However, the Mexican government faces two critical challenges. By one hand, it is the unique purchaser of the environmental services. On the other hand, it is in charge of forest management, which leads to the centralization of these services. Other alternatives are being needed to fix this dual role. Actions have been taken by local governments to introduce these programs among their water users.

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
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InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

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